

## **CHAPTER 2: CBM WATER, SOILS, AND CROP CHARACTERIZATION**

When considering the impacts of CBM water, it is necessary to characterize the water itself, the soils on which the water will be applied, and the crops on which the water may be used.

### **2.1 CBM WATER**

A knowledge of the quality of CBM water is necessary to define the potential impacts of its use and determine its suitability for the irrigation of crops. Rice, et al (2000) developed extensive quality characteristics of CBM water from 47 CBM wells in the Powder River Basin (PRB) in Wyoming. Bauder (1999) also compiled CBM water quality characteristics for 19 wells near Decker, Montana, also in the PRB, and compared the data to that of the Tongue River. For the purposes of this Technical Report, these data are considered representative of the overall PRB and will be used to evaluate the use of CBM water in the Montana portion of the PRB. However, it is important to understand that the quality of CBM water will vary by location in the PRB. Site-specific water quality information should be developed when analyzing impacts for specific use locations.

The high, low, median and mean concentrations of selected constituents in the CBM water from the 47 Wyoming wells are shown in Exhibit 2. The characteristics shown in Exhibit 2 show that a wide variance in quality occurs among the 47 wells, indicating the importance of knowing the quality of the water produced from a specific well or wells that will be used to provide irrigation water to a specific site.

The average constituent concentrations of the 19 Decker wells and surface water from the Tongue River are presented in Exhibit 3. The significant comparisons from these data include the following: Total Dissolved Solids (TDS) averaged four times greater than the Tongue River; Sodium Adsorption Ratio (SAR) averaged 30 to 50 times greater; sodium averaged 15 to 20 times greater; electrical conductivity (EC), chlorides, alkalinity, and bicarbonate averages were only slightly (4 to 5 times) greater; and sulfates and magnesium averages had no significant changes from that of the Tongue River. A comparison of the CBM water data from Exhibits 2 and 3 shows differences in some constituents (mainly, EC, SAR, sodium, and sulfate), which emphasizes the importance of using site-specific data in future impact analyses.

### **2.2 SOILS**

A general soil association map for Montana has been published in a digital format by the U.S. Department of Agriculture's (USDA's) Natural Resources Conservation Services (NRCS). The State Soil Geographic Database (STATSGO) (USDA NRCS 1996) provides a general overview of soils distribution and occurrences in the planning area, and is not suitable for site-specific evaluations. General soils information presented in the STATSGO database is presented in Appendix A. Exhibits include the areal extent, soil series characteristics, K-factor (erodibility factor), salinity, and SAR for the various soil groups in the Powder River and Billings RMAs.

**EXHIBIT 2**  
**CBM WATER CHARACTERISTICS**

Characteristic	Lowest Conc.	Mean Conc.	Median Conc.	Highest Conc.
(mg/L, except as noted)				
pH, units	6.8	7.3	7.3	7.6
EC, dS/M	0.47	1.30	1.13	3.02
Chloride	5.2	13	9.95	64
Sulfate	<0.1	2.4	0.81	8.6
Ammonia	1.1	2.4	2.3	4.8
Calcium	9.1	32	32	69
Fluoride	0.42	0.92	0.895	1.7
Potassium	3.8	8.4	7.6	18
Magnesium	1.6	16	16	46
Sodium	110	300	245	800
SAR, units	5.7	12	8.3	32
Iron	0.03	0.8	0.55	4.9
Aluminum	<0.05	<0.05	<0.05	<0.05
Arsenic	<0.0002	<0.0004	<0.000235	0.0026
Boron	<0.1	<0.107	<0.1	0.217
Beryllium	<0.0001	<0.0001	<0.0001	<0.0001
Cadmium	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	<0.0001	<0.00011	<0.0001	0.00024
Chromium	<0.0001	<0.00098	<0.0001	0.0012
Copper	0.0015	0.00537	0.0041	0.00286
Mercury	<0.000005	<0.00007	<0.0001	0.00025
Lithium	0.018	0.0583	0.047	0.208
Manganese	0.0018	0.0329	0.023	0.101
Nickel	0.0005	0.0065	0.0047	0.0354
Lead	<0.0001	<0.00011	<0.0001	0.00043
Selenium	<0.002	<0.002	<0.002	<0.002
Vanadium	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	<0.001	<0.00406	0.0015	0.0804

**EXHIBIT 3**  
**COMPARISON OF CBMAND TONGUE RIVER WATER QUALITY CHARACTERISTICS**

<b>Characteristic (mg/L, except as noted)</b>	<b>Average Tongue River</b>	<b>Average of 19 Discharge Wells</b>	<b>Change from Tongue River</b>
pH, units	8.2	8.0	Non-Significant
EC, dS/m	0.64	2.39	Increase 4x
TDS	439	1580	Increase 4x
SAR, units	0.79	34.8	Increase 40x
Chloride	3	17.5	Increase 5x
Alkalinity	192	1110	Increase 5x
Bicarbonate	226	1335	Increase 5x
Magnesium	38	25	Non-Significant
Sulfate	174	250	Increase 1.5x
Sodium	32	574	Increase 18x

Source: Bauder 1999

The layout of the soils in the study area is shown and described in Exhibits A-1 through A-3 in Appendix A for the Billings RMA, and Exhibits A-4 through A-6 for the Powder River RMA. The soils generally range from loams to clays, but are principally loams to silty clay loams.

Slope and K-factor are values that are used in the estimation of soil erosion potential. Slope values range up to greater than 40 percent; however, many soils have slopes of zero to about 10 percent that are likely irrigable. Exhibits A-7 and A-8 in Appendix A present the mean K-factor of the soils in the Billings and Powder River RMAs, respectively. The K-factor is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K-factor values (range is from 0.10 to 0.64) are the most erodible. Almost all of the soils have low K-factors (below 0.37). Easily eroded soils have a K-factor between 0.37 and 0.7, and resistant soils have a K-factor less than 0.37 (Jarrett 1995).

Exhibits A-9 and A-10 in Appendix A present the mean of the high range of salinity of the soils in the Billings and Powder River RMAs, respectively. (Note: STATSGO provides a range of low and high values for salinity for soils. The mean of the high value of the range was used to be conservative). Exhibits A-3 and A-6 present the salinity ranges in tabular format. Most of the soils are low in salinity and, with few exceptions, are low in sodium. Exhibit A-11 in Appendix A shows the maximum SAR values for all of the soil mapping units for Montana. The SAR values in the study areas and statewide vary widely, and should be evaluated on a site-specific basis in further studies.

Based on the generally fine texture of the surface soils (clayey), much of the soil will likely be susceptible to increasing sodicity when irrigated with water having a high SAR. Those soils with a coarser texture (sandy to loamy) and good internal drainage will be the least susceptible to increasing sodicity and salinity. Much of the soil is likely to be irrigable with good management. Actual irrigability of the soils, especially those on the higher terraces above the stream valleys, will have to be determined on a site-specific basis.

## 2.3 CROPS AND VEGETATION

The geographical location of the cropped areas in the study area, irrigated and non-irrigated, are shown in Exhibits 4 and 5—Agricultural Land Use Billings RMA and Agricultural Land Use Powder River RMA, respectively (WSAL 1998). Currently, virtually all of the irrigated lands are located in the river and stream valleys. Some dry farming occurs on the higher terraces above the valleys. Some of the land adjacent to the rivers and major tributaries is irrigated for wheat, feed grains, alfalfa, grass hay, sugar beets, and tame pasture (BLM 1992). However, the majority of the area is used for grazing livestock. One observation of Exhibit 5 for the Powder River Basin is there is very little irrigated land along the Tongue and Powder Rivers, which is where a majority of the potential CBM activity, based on the RFD, resides. It would most likely not be economically feasible to transport the CBM produced water long distances from the areas where it is produced to areas where crops are currently irrigated.

The principal irrigated crops grown in the study area and their estimated acreages are shown in Exhibit 6.

**EXHIBIT 6**  
**PRINCIPAL CROPS IN STUDY AREA**

<b>Crop</b>	<b>Irrigated (acre)</b>	<b>Non-Irrigated (acre)</b>
Wheat	17,200	535,100
Barley	27,800	95,700
Oats	5,000	15,400
Corn	37,600	0
Sugar Beets	26,200	0
Alfalfa	139,500	279,500
Grass Hay	49,500	126,500

Source: Montana Department of Agriculture, Agricultural Statistics (2000) for 1999 Crop Year

The most common grass species are western wheatgrass, green needlegrass, needle-and-thread, little bluestem, blue grama, and sideoats grama. Various mid-and tall-grass species, such as switch-grass, Indiangrass, big bluestem, prairie sandreed, little bluestem, sand lovegrass, and needle-and-thread, are found in the sandhills with prairie cordgrass, rushes, and sedge in wetter sites (BLM 1992).

Exhibit 4:  
Agricultural  
Land Use  
Billings  
RMP Area

Legend

Highways

Rivers

STATSGO Soils Map Unit

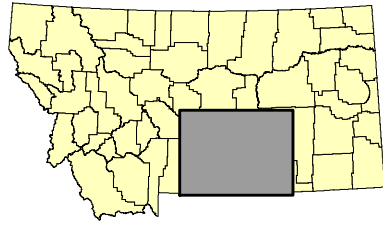
Agricultural, Dry

Agricultural, Irrigated

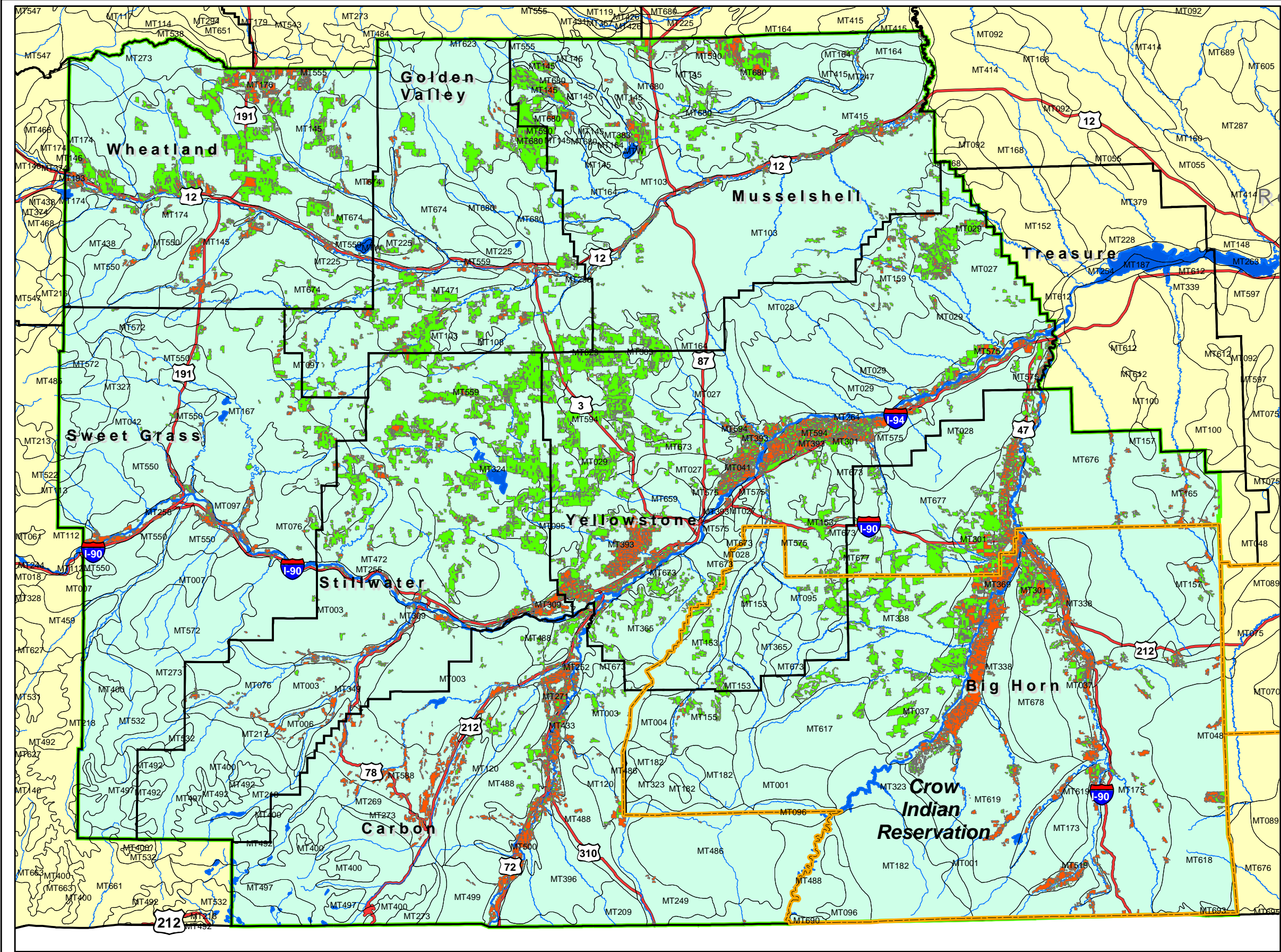
Billings RMP Area

Native American Reservations

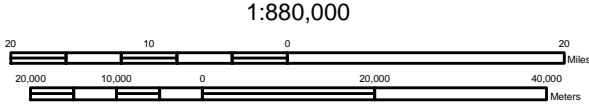
Exhibit presents agricultural lands in the study area both dry and irrigated. Most of the irrigated land is located in the river and stream valleys. Some dry farming occurs on the higher terraces above the valleys.



Location Map











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DATA SOURCES  
Counties: 1:100,000 scale, counties, Montana State Library/NRIS, Helena, Montana.  
Highways: 1:100,000 scale, roads, Montana State Library/NRIS, Helena, Montana.  
Rivers: 1:100,000 scale, rivers, Montana State Library/NRIS, Helena, Montana.  
Soils: 1:250,000 scale, USDA NRCS, STATSGO Database for Montana.  
Agricultural Lands: Montana GAP Analysis.

### Legend

-  Highways
-  Rivers
-  STATSGO Soils Map Unit
-  Powder River Geologic Basin Boundary
-  Powder River RMP Area
-  Agricultural, Dry
-  Agricultural, Irrigated
-  Native American Reservations

A map of the state of Georgia, divided into counties. A gray rectangular box is placed in the southeastern corner of the state, indicating the location of the study area.

